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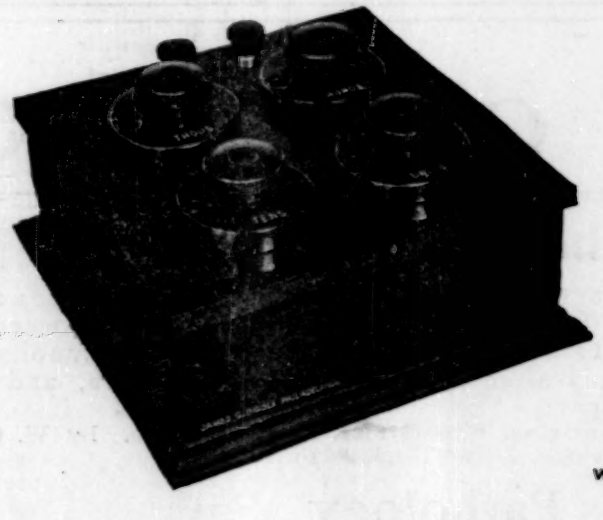

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AMERICAN MATHEMATICS DURING THREE QUARTERS OF A CENTURY[1]

BETWEEN the time of the discovery of America and the middle of the nineteenth century, Europe as a whole had had Euler and Lagrange; England had had Wallis and Newton; France had had Descartes, Fermat, Pascal, Monge and Galois; Italy had had Galileo and Ruffini; Switzerland had had the famous family of Bernoullis; Germany had had Leibnitz and Lambert; Norway had had Abel; but America had had no one who could reasonably be classed with these men as regards mathematical contributions. Nathaniel Bowditch, 1773–1838, is probably most worthy of consideration in this connection, but he fails to measure up to such high standards.

When the first meeting of the American Association for the Advancement of Science was held in 1848, various mathematicians of Europe who were then living had already made contributions which unquestionably outranked the best mathematical contributions that had been made in America up to that time. In support of this we need only remind ourselves of the discoveries relating to the convergence of Taylor's series and the founding of group theory by A. L. Cauchy, the fundamental contributions to number theory and to several other fields by C. F. Gauss, the interpretation of ordinary complex numbers by couples of real numbers and the discovery of quaternions by W. R. Hamilton, the Ausdehnungslehre of H. Grassmann, the projective methods of generating geometric figures due to J. Steiner, etc.

During the year of the first meeting of this association there occurred the death of a very original Bohemian mathematical philosopher whose work failed to receive sufficient recognition until quite recently, *viz.*, B. Bolzano, who had an Italian father and was professor of the philosophy of religion in the University of Prague. It has recently been announced that Bolzano gave the first known example of a continuous function which has no derivative at any of its points, and that as early as 1830 he had developed a method for constructing continuous functions having no derivatives. This is of great historic interest in view of the fact that the later work of Weierstrass and others along the same line attracted unusual attention

[1] Address of vice-president and chairman of Section A —Mathematics—American Association for the Advancement of Science. Cincinnati, Ohio, December, 1923.

when it was made public after 1860. Ignorance of the earlier work due to Bolzano doubtless enhanced the reputation of Weierstrass and others at that time.

In 1848 Europe had half a dozen regular mathematical periodicals, while America had none. The few American mathematical periodicals which had been started earlier had had an ephemeral existence, and this was also the fate of the *Mathematical Monthly* started at Cambridge, Massachusetts, by J. D. Runkle, ten years later. In fact, our first really permanent mathematical periodical was the *American Journal of Mathematics*, of which the first volume appeared 30 years after the first meeting of this association. Four years earlier, the *Analyst* began to appear at Des Moines, Iowa, under the editorship of H. E. Hendricks. It was followed in 1884 by the *Annals of Mathematics*, which has since then rendered very valuable service to the interests of mathematics in our country and is now being published by the Princeton University Press.

The preceding remarks may serve to show that when this association was started America had contributed very little to the advancement of mathematical knowledge, while Europe had a considerable number of mathematical investigators who had already made contributions of the greatest value. This great lead on the part of European mathematicians throws light on the later mathematical developments in our own country. Twenty years after this association was started, a well and favorably known mathematical review, entitled *Jahrbuch über die Fortschritte der Mathematik*, began to appear. In the list of abbreviations for the journals reviewed in this yearbook, no American publication is noted in the first four volumes, although as many as 78 foreign journals appeared already in the first volume and more in later volumes. In the fifth volume, relating to the publications of 1873, the *Transactions of the Connecticut Academy of Arts and Sciences* were noted, and in the later volumes the number of American journals thus noted gradually increased, so that in Volume 45, for 1914 and 1915, there are 13 American journals in a total list of 180. A ratio of about 7¼ per cent. is evidently still too small for our country and does not give due credit to American mathematical contribution a decade ago.

Mathematicians took a relatively insignificant part in the early development of the American Association for the Advancement of Science. The similar organization of Great Britain, France and Italy make a better showing as regards our subject. The most prominent mathematical figure in the early history of our association was Benjamin Peirce, who was elected as the sixth president, and presided at the second meeting held in this state, in 1853,—the first such meeting having been held two years earlier in the city in which we are privileged to meet to-day. The most significant mathematical contribution of Benjamin Peirce was, however, made much later and related to systems of complex numbers obeying the associate law of multiplication; *i.e.*, associative algebras. A memoir on this subject containing the earliest classification of systems of complex numbers was read by him in 1870, before the National Academy of Sciences, and a small number of copies in lithographed form were then distributed. It was published posthumously in 1881, in Volume 4 of the *American Journal of Mathematics*.

The publications on pure mathematics which appeared in the early volumes of the *Proceedings* of this association were insignificant as regards important advances. To illustrate still further the backwardness of American mathematics at that time, we may recall a few facts relating to the history of substitution groups and the Galois theory of equations. During the year in which this association held its first meeting, J. A. Serret taught the former subject in Paris and ten years later R. Dedekind taught the latter in the University of Göttingen. About the same time E. Mathieu and C. Jordan wrote doctors' theses on the theory of substitutions in the University of Paris, and in the early fifties of last century E. Betti wrote various expository articles on substitutions and the Galois theory of equations for the early volumes of the Italian mathematical journal known as the *Annali*. In Great Britain, A. Cayley and W. R. Hamilton were working along the same line at about this time.

We therefore find that during the first decade of the life of this association the mathematicians of France, England, Germany and Italy took an active part in developing and expounding the comparatively new theory of substitutions and the Galois theory of equations which was based thereon. Not only did the American mathematicians take no active part in this development then, but they postponed such activity for about a quarter of a century longer, when J. J. Sylvester gave the first course along this line in Johns Hopkins University during the first half year of 1882–1883. It is well known that American mathematicians soon thereafter began to take a significant part in the development of this field. This activity was inaugurated largely by O. Bolza, F. N. Cole, H. Maschke and E. H. Moore. The success with which later American mathematicians met in this field is partly reflected by the fact that two names of Americans appeared among the eleven which were cited in 1909 in the *Encyclopédie des Sciences Mathématiques* as those who had especially aided in developing this theory. The gradual relative increase of emphasis on the group concept in algebraic work may be illustrated by the fact that in the first 27 volumes of the Jahrbuch (1868–1897) this subject was reviewed under the general heading "Elimination," "Substitu-

tion," etc. In Volume 28 the term "Group" appeared for the first time in the heading. From Volume 29 to Volume 45 the heading began with "Substitution and group theory," but was concluded with "Determinants, elimination and symmetric functions." In Volume 46, covering the three years 1916–1918, the heading was changed to "Group theory" alone. The chapter headings of this volume exhibit also increasing emphasis on this concept in other fields. What is perhaps of more general interest is the fact that while articles on the Galois theory of equations are not found here those relating to the abstract theories of fields, moduli and systems of hypercomplex numbers are classed under the heading of "Group theory" in this volume, so that the first significant American research paper in pure mathematics, *viz.*, the memoir of Benjamin Peirce, to which we referred above, would now be classed in this review as belonging to the general domain of group theory. Hence, the fact that American mathematicians were so slow in entering this field in its substitution group form is the more significant.

The history of the theory of determinants presents a somewhat similar picture as regards late participation on the part of Americans. In 1855 the "Mathematical Dictionary," by Davies and Peck, was copyrighted. The word determinant is not defined therein, although the subject of determinants had then been developed in Europe during several decades and two textbooks on this very useful subject had appeared there. It should, however, be added that a few of the leading American mathematicians began to take notice of this subject about this time, as may be seen from the fact that Benjamin Peirce developed its elements in his "System of Analytic Mechanics," 1855, and that J. E. Oliver published the first article of "A treatise on Determinants" in the closing volume of the *Mathematical Monthly*, 1860. Americans made few contributions towards the development of this subject until much later, and the first American textbook thereon was published by P. Hanus as late as 1886. This was just a quarter of a century after the appearance in England of a small textbook by Spottiswoode on the same subject.

If a well-informed mathematician of the present day could be transported with all his attainments and powers to a world like ours was in the middle of the nineteenth century he would find it easy to attain great eminence in a short time by exhibiting the solution of a system of m linear equations in n unknowns by means of matrices and their ranks, by explaining the applications of the modern theory of integral equations or of the theory of aggregates, by outlining the fundamental concepts of Klein's Erlangen Program, and in many other ways. The great mathematical world progress during the three quarters of a century just closed is, however, not confined to the new theories which have arisen within this period. The additions to the older theories are equally substantial.

During the year in which this association held its first meeting, B. A. Gould, who later became a noted astronomer and president of this association (1868), secured the Ph.D. degree at the University of Göttingen, having studied with the noted mathematician, C. F. Gauss. This calls to mind two important facts relating to the American mathematical situation in the middle of the nineteenth century, *viz.*, many of the ablest mathematicians were also astronomers and made their reputation in the field of astronomy, and some students realized that the European universities offered much greater mathematical opportunities than those of our own country. The latter realization became more pronounced in the early eighties of the last century, when a large number of American mathematical students began to go to Europe, especially to the German universities, for advanced study. As soon as a considerable number of young American mathematical students had an opportunity to become practically as fully acquainted with the fertile fields for research as the young men of Europe, a few Americans began to exhibit as deep an interest in research as their European colleagues. The great mathematical lead which Europe had maintained for centuries seems to be largely due to the fact that its young men enjoyed better advantages than those of our country. At any rate, when Americans in sufficiently large numbers enjoyed similar advantages, they were soon able to effect a marked change in their own country.

In America, productive mathematical research has always been practically confined to the colleges and universities. The most noteworthy exception is furnished by the work of G. W. Hill. We have had no kings who were anxious to attract to their courts the leading mathematicians of the world, nor have we had academies whose income was sufficient to support leading scientific investigators. Among the great national capitals of the world, Washington is conspicuous for not yet having produced or maintained any eminent investigators in pure mathematics. In this respect the comparison with Paris, Berlin, London, Rome, Stockholm, Christiania, etc., is humiliating. If we turn to the catalogues of our colleges for the year when this association held its first meeting we find that Harvard under the leadership of Peirce had then made great recent progress, but even here the comparison with present conditions is very striking.

The catalogue for 1848–49 states that candidates for the freshman class were examined by the mathematical department in the following books: Davies's and Hill's arithmetics; Euler's algebra, or Davies's

first lesson in algebra to extraction of the square root; and "An introduction to geometry and the science of form, prepared from the most approved Prussian textbooks," to "VII of proportions." In the catalogue of Yale for the same years we find that no examination in geometry was required for admission, but that there was an examination in arithmetic and in Day's algebra to quadratic equations. The catalogue of Princeton for these years does also not impose any examination in geometry. In fact, the catalogue for the two preceding years did not even impose an examination in algebra, but the catalogue for the years in question states that an examination is held in arithmetic and in the elements of algebra through simple equations.

What is perhaps of more importance from the standpoint of mathematical research than the limited mathematical preparation on the part of the students is the small number of those giving instruction in our subject. At Harvard we find that Benjamin Peirce was professor of astronomy and mathematics, and that Joseph Lovering was professor of mathematics and natural philosophy. Besides these two professorships, which were only partly devoted to pure mathematics, we find here only one tutor in mathematics. At Yale we find one professor of mathematics and one tutor in the same subject, while at Princeton we find that Stephen Alexander, who about ten years later was elected president of this association, was professor of mathematics and astronomy, while J. T. Duffield was adjunct professor of mathematics.

It should also be noted that mathematicians in these early days allowed themselves to be drawn into too many activities which did not promote their advance in their chosen profession. For instance, Benjamin Peirce was not only professor of astronomy and mathematics, but he did much work on the Nautical Almanac, whose office was located at Cambridge from its inception in 1849 until its removal to Washington in 1866. It is, however, not true that he was in charge of this almanac for some years, as is stated on page 338 of the second edition of Cajori's "History of Mathematics." The men in charge during the life time of Benjamin Peirce were, in order: C. H. Davis (1849–1856), Joseph Winlock (1856–1859), C. H. Davis (1859–1861), Joseph Winlock (1861–1865), J. H. Coffin (1865–1877), and Simon Newcomb (1877–1894). Peirce was consulting astronomer from 1849 to 1867.

He wrote a considerable number of elementary mathematical textbooks for the Harvard students and was also superintendent of the U. S. Coast Survey from 1867 to 1874. From 1852 to 1867 he was in charge of the longitude determination of this survey, etc. In view of these varied and absorbing interests, it is not surprising that he failed to keep in close touch with some of the results of the eminent European mathematical investigators of his days. Such close touch on a large scale was not maintained by American mathematicians until about the middle of the period under consideration.

The wide difference between the mathematical situation of those days and of our own time is also illustrated by the biography of J. H. Van Amringe, the first president of the American Mathematical Society. Even before he graduated from Columbia College in 1860, with the A.B. degree, he was tendered an instructorship in no fewer than five widely different departments, *viz.*, Greek, Latin, history, chemistry and mathematics. He chose mathematics and taught this subject there for almost half a century, serving also as dean of the college for a number of years, but never becoming a mathematician in the modern sense of this term. A dozen years after this association was founded, and for about two decades longer, we find that a graduate with the A.B. degree was regarded as sufficiently well trained to assume a regular instructorship even in some of our leading institutions.

The list of presidents of this associatioon includes the names of a considerable number of the most eminent scientists of our country. We find therein several who are known in the history of mathematics, but not until 1922 do we find one who was noted principally on account of his achievements in pure mathematics. In fact, there was only one predecessor who held the simple title of professor of mathematics at the time he served as president of this association, *viz.*, H. A. Newton, who was president in 1885 while he occupied the chair of professor of mathematics in Yale University. His reputation was, however, based principally on his work on meteors and not on contributions towards the advancement of mathematical knowledge. He never attained eminence in this field.

Benjamin Peirce was professor of astronomy and mathematics in Harvard, when he served as president of this association in 1853, and was then widely known on account of his researches relating to the perturbations of Uranus and Neptune. Joseph Lovering, who presided over this association twenty years later, was then professor of mathematics and natural philosophy in the same institution and was known chiefly for his contributions to the latter subject. Alexis Caswell, who presided in 1857, was professor of mathematics and astronomy in Brown University and was noted principally as an astronomer and educator. His scientific attainments were meager. He later became president of Brown. R. S. Woodward, who presided in 1900, was then professor of mechanics and mathematical physics in Columbia University, and was noted for work in applied mathematics.

The list of presidents of the British Association is

naturally more favorable as regards pure mathematics. Four years before our association was started the British association had as president George Peacock, who is known chiefly for his work in formal mathematics and for historical articles on our subject. He was one of the founders of the Analytic Society, which had for its object the introduction into England of the calculus notation used on the continent of Europe, but he was never very eminent as a mathematician. In 1878 William Spottiswoode was president of the British association. He was a more eminent mathematician and was also known chiefly for his work in pure mathematics, having published the first book on the theory of determinants in 1851, and having assisted in the development of various mathematical subjects. Five years later, Arthur Cayley, the most eminent of the pure mathematicians of Great Britain, served as president of the British association. J. J. Sylvester, the second in eminence among these mathematicians, was president of Section A (mathematics and physics) in 1869, but he never served as president of the entire association.

During the first third of the period under consideration, American mathematicians were comparatively isolated and they developed like the isolated trees, with many relatively large branches—not growing very tall, but having the breadth and the grandeur associated with the tree that stands alone. Later, when mathematical journals became more general, many of them developed like the trees of the forest, with much greater height, but with much less imposing branches and breadth. They became members of the common mathematical forest, and had to grow tall to receive sunshine. In particular, the pure mathematician had either to grow tall or to stifle in the shade of his European colleagues working along similar lines. Comparatively few such forest trees have developed into giants among us, but these few have tended to remove the stigma formerly associated in our land with being only a mathematician. It is beginning to be recognized that to be a giant in the forest of mathematics it is necessary to develop upward rather than to develop imposing branches.

If we may carry this figure a little further, it may be noted that the fruit trees, as a rule, do best when they are somewhat isolated. These are typified by those who are interested mainly in teaching. The teacher who desires to serve most efficiently has usually found it necessary to direct his development along the line of the isolated tree. The same is true to a large extent as regards those working in applied mathematics. The dense mathematical forest is not the place for these. They need more space for breath. Until recently the American Association for the Advancement of Science could find no tree in the mathematical forest which was both American and of sufficient magnitude to bear its highest office with dignity. We all rejoice that this association recently acknowledged the existence of one such in the person of E. H. Moore, a native of the state in which we are meeting.

While we are proud of the fact that the common mathematical forest of the world contains already a considerable number of American trees whose size is attracting favorable comment everywhere, and that the number of smaller American trees in this forest which are growing upward rapidly and give great promise of becoming some of the most imposing trees therein is rapidly increasing, we can not afford to neglect paying due respect to the fruit trees and to the other isolated trees with their magnificent proportions and symmetry. The forest tree is most valuable for certain types of service, but for other types the fruit trees are more valuable. The former are naturally attracting most of our attention at present because they are such recent products of our history and they have a more permanent value. They are now especially the centers of interest of the American Mathematical Society, while the Mathematical Association of America and the National Council of Teachers of Mathematics center their interests in the latter.

It was noted above that E. H. Moore was one of the inaugurators of the successful study of group theory in our land. His most eminent student in this field is L. E. Dickson. It has also been noted that Americans entered this field long after various Europeans had begun to cultivate it with marked success. This observation might give an erroneous impression unless we add that new phases of this subject presented themselves later and some Americans aided in the development of these from the beginning. In particular, the subject of finite continuous transformation groups was opened by Sophus Lie in about 1874, only two years before Johns Hopkins University opened its doors to students, and hence this subject was practically new when a considerable number of Americans began to take an active part in mathematical research. The foundation of the theory of infinite continuous groups was laid about ten years later (1883). The geometry of infinite discontinuous groups was opened by Camille Jordan, Sophus Lie and Felix Klein, at a slightly earlier date. A little later, about 1882, Henri Poincaré illustrated in a striking manner by his theory of Fuchsian functions the services which certain discontinuous infinite groups are able to render in the theory of functions. About 1896 Georg Frobenius opened up a practically new and extensive field in the theory of linear groups of finite order by his study of group characteristics and related subjects. A number of smaller new fields in group theory, such as those of the group of isomorphisms (1893) and the commutator sub-group

(1896) were opened from time to time. Into these newer fields of group theory certain Americans entered either from the beginning or soon thereafter. There is, therefore, a striking contrast between their entrance into these newer fields and their entrance into the fields of the elements of finite substitution groups and abstract groups, as noted above. Fashions in group theory, as well as in other mathematical subjects, have changed fairly rapidly during the last three quarters of a century, so that the stylish intellectual dresser in this subject could easily be distinguished from those who were more or less old fashioned.

While styles have changed within group theory itself, it seems that these changes have not been sufficiently rapid or sufficiently radical to satisfy all those who dress in accord with the most recent approved intellectual fashion. Some of these abandoned, either temporarily or permanently, the ranks of the group theory force and joined with success others, in particular the postulationalists, when these came to render conspicuous and much needed service to our science. Oscar Bolza, on the other hand, left the ranks of the workers in group theory to join the force which had created a new and wholesome interest in the older subject of calculus of variations. American mathematical contributions have been greatly enriched by the disciples of Bolza, such as G. A. Bliss, in this great field. Changes in main interests have doubtless been very wholesome when they were effected with such success as has been the case in several instances in the history of American mathematics.

We have already mentioned three fields in which American mathematicians have rendered conspicuous service during the last forty years, *viz.*, group theory, postulates and the calculus of variations. It would be very unfortunate if we should convey the impression that American mathematical contributions were practically limited to these fields. In at least two other fields Americans have secured international prizes during the period under consideration, and in others the recognition has been equally definite. The reasons why we have paid more attention to the first of the fields mentioned above are that it comes first historically from the standpoint of considerable researches, and that we are able to speak about it with more certainty than about some of the other fields. The question of relative importance is a difficult one and has not been raised here. We all delight in every serious mathematical contribution, and may be pardoned if we delight especially in American contributions of fundamental importance regardless of the particular line of work to which they relate.

The greatest mathematical monuments which America has raised during the period under consideration are its series of periodicals. In particular, the *American Journal of Mathematics,* the *Annals of Mathematics,* the *Bulletin of the American Mathematical Society,* the *American Mathematical Monthly,* the *Transactions of the American Mathematical Society,* and the *Mathematics Teacher.* Compared with the older European series, several of which extend beyond 100 volumes apiece, these American series are as yet quite limited, since none of them has reached its 50th volume. They represent, however, a very substantial mathematical contribution made by Americans collectively within half a century. On the other hand, the mathematical advances found in American textbooks and treatises have not yet been extensive and are practically confined to works which appeared during the last two decades. In particular, our country has not produced a calculus which compares favorably with Jordan's "Cours d' Analyse" as regards extent and originality, nor has it produced an algebra which appears creditable from this point of view when compared with Weber's "Lehrbuch der Algebra." In function theory the works of Osgood and Pierpont, and in geometry the works of Veblen and Eisenhart, are conspicuous examples of recent advances in American textbooks as regards the point of view in question.

During the period under consideration several brief series of mathematical periodicals have also arisen in our land. The most advanced of these was the *Mathematical Review* which was expected to appear bimonthly under the editorship of W. E. Story, of Clark University. This university lately discontinued its mathematical department on account of lack of funds. During the second half of the period under consideration Clark University exerted a strong influence on advanced mathematical work in our country, as may be seen from the work of those who secured their doctor degrees at this institution. Hence the mathematical public regrets very much that this source of mathematical activity had to be discontinued. It is, however, a consolation to be able to note that since the time when this *Review* was started and when mathematical activity at Clark was at its peak many new centers of such activity have been created in our midst. The first number of this *Review* appeared in July, 1896; the second number appeared about nine months later, while a third number appeared in 1899. No additional numbers have appeared. Two journals of the older type, *viz.*, the *Mathematical Visitor* and the *Mathematical Magazine,* were started by Artemas Martin in 1877 and 1882, respectively. These journals were devoted mainly to solutions of problems, and the successive numbers appeared too irregularly and at too long intervals to be very useful. In particular, the second part of number 12 of volume 2 of

the latter journal was dated September 1910, more than 28 years after the date of the first number of volume 1.

The tendency towards forming national mathematical organizations with regular official journals is one of the noteworthy developments of the second half of the nineteenth century, and it was represented in our country by the organization of the American Mathematical Society in 1888. Within the last decade this tendency manifested itself strikingly among us by two new national mathematical organizations. The younger and larger of these is the National Council of Teachers of Mathematics, organized in 1920 and having a membership of more than 3,000. The official journal of this society is the *Mathematics Teacher*, which had been previously published by the Association of Teachers of Mathematics in the Middle States and Maryland. The older of these two mathematical organizations is the Mathematical Association of America, to which we referred above.

America has had its share of successful elementary textbook writers who secured considerable reputation on the part of the general public. In addition to these there have been hundreds who published textbooks which were designed to meet special local needs, but which often had greater faults than were possessed by the books which they replaced. Much energy has doubtless been wasted here which should have been directed towards higher mathematical attainments on the part of the authors. Substantial improvements in textbooks are, however, very important, and authors usually learn something about the subject while preparing the manuscript of a textbook.

America has also had its share of the so-called mathematical prodigies. Among these T. H. Safford (1836–1901) is well known. He became professor of astronomy in Williams College in 1876. In his eleventh year he is said to have published an almanac, computed for this city, which soon reached a sale of 24,000 copies. Mathematical prodigies, like the successful elementary textbook writers, secured considerable public notice, but most of them contributed little or nothing towards the development of our subject. Their marvelous mathematical feats are of more interest to the psychologist than to the mathematician. In Europe Ampère and Gauss are noted as prodigies and they are also noted contributors towards the advancement of our subject, but in America the mathematical prodigies have thus far contributed little to the advancement of pure mathematics.

The actual and relative mathematical advances made by Americans during the last 75 years are conspicuous, but not satisfying. We have not yet attained relatively as high a standing as we should aim to attain, or as those belonging to some of the other sections of this association—such as the astronomers and the geologists—have already attained. Not one of the 50 incorporators of the National Academy of Sciences had made important contributions to the increase of our knowledge of pure mathematics, although six of them enrolled in the section of mathematics. It is only recently (1920) that this association recognized conspicuously the advances in American mathematics by devoting an entire section to them. From 1882 to 1919 mathematics and astronomy constituted one section, and the astronomers usually commanded the major interest at our meetings. Let us hope that the letter which has been assigned to our section will represent in the future not only the fundamental character of our subject, but also the relative advances made therein. To work hard and long before receiving public recognition seems to be the lot of most of us, but the sense of growth is keen and definite in our field and this sense of growing intellectual insight and power is our main reward as regards mathematical research.

G. A. MILLER

UNIVERSITY OF ILLINOIS

THE PRACTICAL VALUE OF PURE SCIENCE[1]

WHEN I reflect that preceding Edison medallists have been men of the type of Charles F. Brush, who first showed the world that electricity might be used for city lighting; Alexander Graham Bell, whose invention was at the base of the whole vast system of modern communications; Frank Sprague, who was responsible for the application of electric power to railway transportation; M. I. Pupin, who made long distance telephony possible; J. J. Carty, under whose inspiration and leadership the telephone repeater and amplifier, with all that they mean to the enrichment of modern life, have been brought forth, and others of like achievement in the application of electricity to large industrial uses, I feel that there may have been a misunderstanding or a mistake in connection with this year's award. For when I look over my thirty years of scientific effort I can find no industry which has grown out of my researches, nor even any which have been very immediately benefited by them.

Since this survey certainly reveals nothing of great industrial consequence I am obliged to adopt either the mistake-theory, or, as an alternative, to assume

[1] Response to the presentation of the Edison Medal at Del Monte on the evening of October 4, when the president's presentation address was made by Dr. Frank B. Jewett from his home in New Jersey, his voice being carried over telephone lines and amplified through the magnivox so as to be very distinctly audible to the entire audience seated at dinner in the Del Monte Hotel, three thousand miles away.

that the American Institute of Electrical Engineers has this year been led to adopt a new policy—a policy of recognizing occasionally, at least, as something of vital, practical importance to the world, a type of activity which does not lead to immediate industrial advances. I am going to assume that this last hypothesis is correct, and in behalf of all workers in what is called the field of pure science, all those who are spending their lives in trying merely to ferret out nature's secrets and to better man's understanding of her laws, I wish not only to express my appreciation to the Institute for the award, but also to compliment it upon the breadth of its own vision and the service to science which it has done in recognizing before the public the value of this other field. For, in the final analysis, the thing in this world which is of most supreme importance, indeed the thing which is of most *practical* value to the race, is not, after all, useful discovery or invention, but that which lies far back of them, namely, "the way men think"—the kind of conceptions which they have about the world in which they live and their own relations to it. It is this expanding of the mind of man, this clarifying of his conceptions through the discovery of truth which is the immediate object of all studies in the field of pure science. Behind that object, however, is the conviction that human life will ultimately be enriched by every increase in man's knowledge of the way in which nature works, since obviously the first step in the beneficent control of nature is a thorough understanding of her.

To illustrate my contention that the way men think is the most important and the most practical thing in human progress, I wish to consider briefly two great epochs in history in which significant changes have been brought about in man's conception of his world and of the place he occupies in it. The first epoch began just 450 years ago; for this year happens to be the 450th anniversary of the birth of Copernicus, or, as he was known in his native Poland, Nikolaus Copernik, a man who spent his life not primarily in the pursuit of astronomy, but rather in the service of the church, for he was Canon of the Cathedral of Frauenberg. This man was more than any other responsible for changing the conceptions of mankind about what some men who call themselves practical would say had no bearing upon this life of ours at all, and yet there was not a political or social change in Europe during the two or three succeeding centuries which it did not affect.

It is not strange that through all the ages up to the time of Copernicus the earth had been the center of man's universe, nor indeed that his whole thinking had been ego-centric—that he felt that the universe had been created especially for him with every bird and beast and flower ministering to his pleasure. Nor is it strange that in spite of this self-centered conception, surrounded as he was with mysterious forces, his philosophy of life had been a supinely fatalistic one, that little idea had as yet entered his mind that he himself might have any real control over nature, or that he had any responsibility for the shaping of human destinies. In all the ancient world three blind fates sat down in dark and dank inferno and spun out the lives of men. Man himself was not a vital agent in the march of things; he was but a speck tossed hither and thither in the play of mysterious, titanic, uncontrollable forces. Even after the advent of Christianity no idea of the possibility of changing bad conditions by human effort gained access to his thinking. The best that he could do was to withdraw from the world and to cultivate his soul in a monastery, or to mortify the flesh after the manner of the pillar-saints, in the hope of reaping a reward in the next world for his piety.

Now note first the simplicity of the process by which a change in his thinking begins to come about, and then note the result. The simplicity of the process has been characteristic of the advance of science in all ages. Careful observations, such as men made in those days as well as this, had brought out difficulties in the explanations which had come down from the past. The dome of heaven rotating about the earth and carrying the fixed stars, and other transparent crystalline domes carrying the planets and the sun and rotating at different speeds, were simple enough if one is not too insistent upon the requirements of mechanical engineering, but careful observation had shown retrograde motions, at certain seasons, of the planets now known to be outside the earth's orbit, which are actually due to the fact that the earth itself is at these times speeding between these outer planets and the sun at an angular speed greater than their own, thus causing them to seem to go backward. Such phenomena imposed impossible conditions upon the crystalline domes of the ancients unless the most complicated and grotesque assumptions were made. Copernicus wrote his only book to show that all these difficulties disappeared and all explanations came out vastly more simply if the earth is assumed to be but one of a number of little planets rotating once a day upon its axis and circling once a year about the sun. But realizing that this new conception might arouse opposition because it robbed man of his central position in the scheme of things he wrote to the Pope, to whom he dedicated his book, asking him to use his influence to defend him from those who might attack his theory "because of some passage of Scripture which they had falsely distorted for their own purposes." Here is a devoutly religious man 400 years ago of sufficient vision to see, even in the dim light

of that shadowy age, that the foundations of real religion are not laid where scientific discoveries of any kind can disturb them, and who therefore keeps his mind open at all times to truth from whatever angle it tries to enter.

But now look at the results of the introduction of this new way of thinking upon a subject which had apparently no industrial or commercial bearings whatever. The shock to tradition and to established custom was too great for the unseeing of his day as it is of ours. The Inquisition came and the frightful religious wars of the next two centuries all because of the introduction of some new ideas into men's minds. Truly *the way men think* is the most practical concern in life, for all conduct flows from it!

But slowly the truth prevailed, and for four centuries the sciences of celestial mechanics and of Newtonian dynamics had greater and greater successes until it became impossible for even the most narrow visioned and unintelligent of men to doubt the fundamental correctness of Copernicus's ideas, even though they had been branded at their inception by popes and emperors and scholars, even as enlightened a one as Luther, as impious and untrue because they were "in direct contradiction to the Scriptures."

The second epoch of which I wish to speak is that in which we live; for it is quite as extraordinary as that of Copernicus in the rapidity with which new conceptions are being introduced and in the influence of these conceptions upon human life and conduct. Look at what has happened within my own life time in the field of physics, for example. When I started my graduate work in 1893 so sure were we of the physical foundations of our world, with its seventy-odd, unchangeable, indestructible elements, its well-formulated laws of matter-physics and its equally firmly established laws of ether-physics—ethereal and material phenomenon being sharply and definitely differentiable—and the principles of the conservation of energy, the conservation of mass, and the conservation of momentum acting as nature's policemen to keep the universe running eternally within the law, that it was then being frequently said, often by the ablest of physicists, that it was probable that all the great discoveries in physics had already been made and that future progress was likely to arise only by increasing the refinement of our measurements. Then came, only two years thereafter, the capital discovery of X-rays, an entirely new phenomenon, having no relation whatever to refinements of measurement. And two years later came radioactivity, which has now completely exploded the notion of the eternal character of the atom and revealed a world in which many if not all of the so-called elements are continually undergoing change, spontaneously shooting off projectiles with stupendous speeds, speeds far beyond those which it had ever been thought possible that matter in any form could attain. And then three years later came the beginnings of the quantum theory, which has shown us unmistakably (so it appears) that in the domain in which electrons live even Newton's laws no longer hold. And then a few years later, through Einstein's insight or speculations, as you prefer, mass and energy became interconvertible terms, and now we are all agreed that our former sharp distinctions between material, electrical and ethereal phenomenon have got to be abandoned. And, most important of all, from the amazing progress of physics has come more and more to the fore the idea that man has himself the ultimate ability to control for his own ends many of the changes going on in this changing world. How could it be otherwise when within a hundred years the very greatest of modern industries, that represented by the American Institute of Electrical Engineers, has been created through man's gaining year by year a larger and larger control of what used to be the most mysterious and apparently the most uncontrollable phenomenon of nature, the thunderbolts of Jove.

And geology, too, is telling us the same kind of a story. It is but fifty years since the death of Lyell, a man who, more perhaps than any other, first taught us to read the story of the rocks, yet now so well have we learned the lesson that to use a single illustration we count the exact number of years since the last ice age by the annual deposits on the shores of the Baltic Sea in just the same way as we obtain the age of a tree by the counting of its rings. And through all this expanding knowledge has come the definite evidence that man himself has been here perhaps a hundred thousand years, and yet that his extraordinary development, not physiologically, perhaps, but socially, has been exceedingly recent, much of it within a generation or two, since the developments in physics have given him control of the giant forces formerly wielded only by the Titans.

And the developments in biology taking place under our very eyes tell the same story. Bacteriology has already banished some of man's most dreaded scourges. In the fields of agriculture, horticulture and animal husbandry, man now builds plants and fruits, and even animals almost to suit his taste. If he hasn't a drought-resisting wheat, a seedless orange or a grape he goes to work to make one. If he does not find an ox adapted to resist the Texas winds like the buffalo and to put on flesh like a Durham, he creates one. As a result, then, of the modern pursuit of pure science in all its branches—the following of that inner urge simply to know, to explore, to understand, two new ideas completely foreign to the ancient world and to many races of the modern world as well have come into our western civilization. The one is

the idea of the possibility of progress, of continuous development; and the other the idea of man's ability to control and in the Providence of God (and I say it in all reverence) to determine to a large extent his own destiny, the idea of his own responsibility for the kind of an external world in which he lives. And if you wish to see the practical result of this changing of "the way men think," look at the difference between our own civilization and the static civilizations of Asia, where Nirvana is the goal of human life and a large fraction of the population reaches it quickly through starvation. Why is it that "fifty years of Europe is better than a cycle of Cathay"? Is it not simply because in certain sections of the world, primarily those inhabited by the Nordic race, a certain set of ideas have got a start in men's minds, the ideas of progress and of responsibility.

And these ideas have come about, I think, because in a few sections of the earth men have been led to follow simply the urge to know. First, to know this earth geographically, to explore it clear to the north pole and to the south pole, even when they knew there was not the remotest prospect of growing wheat or potatoes there. But now the days of geographical exploration are gone, and yet it is the same urge which leads on the descendants of these voyagers into the unknown—the astronomer to explore the heavens, however useless that may be, the physicist to study the properties of matter and radiant energy whether he sees any immediate use for his results or not, the biologist to delve as far as he can into the secrets of life and of organic growth.

On behalf of all those who are working in the field of pure science, all those pioneers who are pushing out beyond the present frontiers of human knowledge —where a few years hence the engineer and the other builders of a future more perfect civilization than our own will follow them—on behalf of all those who are struggling on in this field, which does not often meet with large public appreciation, I extend my heartfelt thanks to the American Institute of Electrical Engineers for helping to educate the public up to its values by recognizing it with an occasional Edison award.

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GUSTAF ENESTRÖM

THE recent death of Gustaf Eneström, of Stockholm, removes a most distinguished investigator from the field of the history of mathematics. For eighteen years editor of the *Bibliotheca mathematica,* a journal founded by him and devoted to the history of mathematics, he wielded a most powerful influence for greater thoroughness in historical research.

Eneström was born at Nora, in Sweden, on September 5, 1852. Trained mainly in mathematics and languages, he became connected in 1875 with the library of the University of Upsala and in 1879 with the royal library of Stockholm. Through his work as librarian he acquired extraordinary ability in matters of bibliography. Before 1899 he had comparatively little time for historical investigation. Later he came to enjoy greater leisure for research and he also acquired possession of large collections of mathematical books which afforded facilities for consulting original sources, such as perhaps few historians of mathematics have enjoyed.

Trained as a bibliographer, he possessed to a degree probably never before equalled, the art of bringing all the resources of a library to bear upon a particular problem. He had the patience for working out the details of an inquiry with extreme precision. As a result, his conclusions have been found to be almost invariably correct. He is the author of numerous short papers on mathematical history, but much of his work consisted in correcting errors of others, particularly of Moritz Cantor, the author of the well-known "Vorlesungen über Geschichte der Mathematik." Unlike the performances of certain other modern critics of historical works, Eneström's findings almost without exception constituted the final word on the subject.

Cantor and Eneström were wholly different minds. Cantor possessed the faculty of portraying in bold relief the history of his science extending over long periods of time. Unaided, he prepared three massive volumes carrying the history of mathematics from the earliest historic times to the year 1759. In this general survey some of the minute details received inaccurate statement. Eneström, on the other hand, never wrote a general history, nor even the history of a particular period. He devoted fifteen years to the microscopic examination of the ponderous volumes of Cantor. His notes are a store-house of information which no historian of mathematics can afford to ignore. Eneström's influence upon the younger generation of writers has been great. The historical notes in the French "Encyclopédie des sciences mathématiques" carry the marks of his thoroughness.

At the outbreak of the great war, the printing of the "Bibliotheca mathematica" was permanently suspended by Teubner in Leipzig. It was a great disappointment to Eneström that after the war no one in America seemed willing to finance the journal as an American publication.

FLORIAN CAJORI

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SCIENTIFIC EVENTS

RESEARCH IN THE DYE INDUSTRY

OF the 209 firms engaged in the manufacture of dyes and other coal-tar chemicals, 67 had separately organized research laboratories for the solution of technical problems and for the development or discovery of new products, according to the U. S. Tariff Commission's recent "Census of Dyes and Other Synthetic Organic Chemicals," as reported in *Chemical and Metallurgical Engineering*. The net operating expenses of these laboratories, together with research work done in the laboratories not separately organized for research, were $2,172,508. This includes salaries, apparatus and materials, after deducting the value of salable products made in the research laboratories. The figure for 1922 shows a decrease of $2,074,160 compared with that of 1921. This figure is doubtless an understatement of the real cost of experimental work, since it does not include, in all cases, the cost of research done as a part of manufacturing operations and not shown on the books of the companies as a charge against research.

The coal-tar chemical industry in the United States has expended $21,545,915 in research work alone, according to reports to the Tariff Commission, during the last five years (1917–1922); with the exception of the year 1917 this is net, and does not include the value of salable products made in the experimental department. The energetic and extensive investigations into the manufacture of dyes have been greater probably than in any other field of chemical research. The achievements of this period, 1917–1922—namely, the establishment of a large dye and synthetic organic chemical industry, with its early progress and development—must be attributed in no small part to the enormous expenditures in research.

The expenditures for research decreased during 1921, and still more so in 1922, because many concerns were obliged to retrench when business conditions were poor. While this no doubt retarded the progress of the industry to some extent, there were nevertheless advances made during that period and progress may be expected in the report for 1923.

OFFICIAL STATEMENT OF THE AMERICAN MEDICAL ASSOCIATION ON MEDICAL LICENSURE

AT the meeting of the executive committee of the Board of Trustees of the American Medical Association held on December 12, it was decided to issue a statement for the public on the position of the American Medical Association relative to the recent scandal in medical licensure. In accordance with this action, the committee has issued the following statement to the press:

For more than twenty years, the attention of the public has been regularly directed, in official publications of the association, to the evils from which the present scandal arose. The existence of low grade medical schools which refused to raise their standards, which refused to permit inspection and which refused even to submit lists of their students has been regularly noted. The dangers of multiple licensing boards in certain states which issued permits to practice to men who could not qualify for or successfully pass the regular boards have also been made the subject of warning statements. Since 1918, the *Journal* of the American Medical Association has published annually the fact that the Connecticut and Arkansas eclectic licensing boards were apparently serving as clearing houses for low grade institutions in Missouri. In 1920, the *Journal* pointed out that Connecticut, through its eclectic board, was licensing men who had not studied in eclectic medical schools, and even worse, was licensing some men who apparently had not completed a medical course in any school. The American Medical Association is a body which has no punitive powers. It could not arrest and prosecute; it could only point out to state officials the festering evils which required their official attention. Nevertheless, public officials have consistently disregarded these announcements until the sensational publicity accorded an exposé by a St. Louis newspaper forced the matter on their attention.

The statement of a man under indictment in connection with diploma frauds in Missouri that there are more than 25,000 physicians in the United States practicing with false credentials has been made the subject of numerous editorials, in which the medical profession has been urged to keep these impostors from deluding the public. At the headquarters of the American Medical Association is a card index which contains a card for every man licensed to practice medicine in the United States. Through this card index, and through its records of the men who attend medical schools, the association is able to say positively that the number of medical impostors and poorly qualified physicians does not even approximate 25,000. During the past eight years, not more than 2,500 men, who have been given diplomas by low grade medical schools, have received state licenses.

There are to-day five medical schools in the United States which are not up to the high standard of the remaining seventy-six. If these schools are forced to raise their requirements or else to discontinue, the public will be assured that no men will be graduated in medicine who are not qualified to appear for licensure. If the state licensing boards will then admit to their examinations only those who are qualified, the public will have assurance that any man who can present the license of the state examining board is a properly qualified physician. The existence of multiple licensing boards in certain states, which permit men not qualified for the regular board to pass certain special boards, is a constant menace. Finally, the public will not be safe from the medical impostor until the police power of the state is ever alert to search out and prosecute the man who is practicing medicine without a license.

THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

THE ninth annual meeting of the American Association of Petroleum Geologists will be held at Houston, Texas, on March 27, 28 and 29, 1924. Headquarters will be established at the Rice Hotel.

It is planned to make this one of the most successful and interesting meetings in the history of the association. All members of the Houston Geological Society are giving their hearty cooperation to this end and will present a valued addition to Gulf Coast Geology in the form of a monograph of salt domes.

Arrangements have been made to present strong papers on geological and technological subjects of vital and general interest to the oil fraternity. Two sessions are allotted for the discussion of salt domes and this time will be used in thoroughly describing and discussing a few of the more important fields, together with notations on the various problems encountered in their development. The time allotted for salt dome discussions is not sufficient to permit the reading of all papers; however, every dome in Texas and Louisiana will be described in detail and published in the bulletin, together with a map showing Topography, Stratigraphy, Cross Sections and Development. Mr. E. DeGolyer, a very able student of salt domes in the United States and foreign countries, will present a paper on "The Origin of Salt Domes."

The meeting will include a number of field trips to some of the more important domes to show the visiting members what a salt dome looks like, its surface indications and their relation to production. The inside of a dome will also be inspected at Avery's Island, La., as well as methods employed in mining sulphur at Freeport, Texas. These trips will offer an exceptional opportunity for those who are not familiar with rotary methods and the problems peculiar to salt dome structures; they are planned to take place as follows: March 28, Automobile trip to Barbers Hill and Goose Creek Oil Fields. March 30, Special train to Freeport Sulphur Mine and Hoskins Mound. March 31, Trip by Southern Pacific R. R. to Avery's Island, La. April 1, Final trip to Palestine visiting two or three of the inland domes.

THE PAN-PACIFIC FOOD CONSERVATION CONGRESS

THE Pan-Pacific Food Conservation Congress will convene in Honolulu from Thursday, July 31, to Thursday, August 14, 1924.

Dr. L. O. Howard, chief of the Bureau of Entomology of the U. S. Department of Agriculture, is temporary chairman and will open the conference. The sessions will be held in the Territorial Executive Building, the old Iolani Palace. The local committee will entertain the delegates—the Chinese community one day, the Japanese another, then the Koreans, the Filipinos, the Americans, the Canadians, the Hawaiians and the Anzaconians or Australasians living in Hawaii, each day's entertainment to be typical of the race entertaining.

The scientific men of the Hawaiian Sugar Planters' Experiment Station will look after the delegates, and in this they will have the assistance of members of the faculty of the University of Hawaii, which is the Territorial Agricultural Institution. It is probable that considerably more than a hundred delegates from Pan-Pacific countries will attend this conference.

There will be a trip to the volcano of Kilauea, and visits to the sugar and pineapple plantations. Native Hawaiians will receive the delegates to the Fisheries section of the conference.

The Honorable Wallace R. Farrington, governor of Hawaii, and president of the Pan-Pacific Union, is now in Washington to take up there the matter of American representation. He will be followed shortly by the director.

The conference will be held in ten sections as follows: International agreements regarding fisheries, economic entomology, plant pathology, international quarantine policies, crop production and improvement, forestry, climatology, transportation and distribution of food products, topography—land and sea—and animal husbandry.

CELEBRATION OF THE TWENTY-FIFTH ANNIVERSARY OF THE DISCOVERY OF RADIUM

THE twenty-fifth anniversary of the announcement of the discovery of radium to the Paris Academy of Sciences was celebrated at four o'clock on December 26 at the Sorbonne with ceremonies over which M. Millerand presided. Addresses were made by Rector Appell, of the University of Paris, Professor Perrin, of the Sorbonne; Dr. Declere, of the Academy of Medicine, and Leon Bérard, minister of public instruction.

President Millerand emphasized the importance of the discovery of radium and voiced the gratitude of the world to Mme. Curie. Mme. Curie, in a brief response, expressed regret that her husband had not lived to receive the honors due him.

As an evidence of national appreciation, the chamber of deputies passed a bill conferring on Mme. Curie an annuity of forty thousand francs, which was presented to her on this occasion.

M. Bérard, Minister of Public Instruction, who introduced the bill, made the following statement to the chamber, setting forth his reasons for recommending its passage:

Our whole conception of matter, chemistry and the science of the universe has been placed on an entirely new basis; in addition, the emanations emitted in the transmutation of tne atoms of radium have been found to mutation of the atoms of radium have been found to fective means have been discovered by which certain evils from which humanity suffers, such as cancer, can be combated. The strange and profoundly new character of these discoveries, the practical developments associated with them, and the hopes that they awaken for the future, create for France the moral obligation of showing its gratitude to those who made possible this glorious event. Unfortunately, Pierre Curie passed away prematurely. With admirable faith, firm resolve and scientific self-denial, Madame Curie is continuing the work so auspiciously begun. The hour has come for France to show her grateful appreciation.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

AT the Cincinnati meeting of the American Association for the Advancement of Science, Dr. J. McKeen Cattell, president of the Psychological Corporation and editor of SCIENCE, was elected president. Vice-presidents were elected as follows: *Mathematics,* Professor John Charles Fields, University of Toronto; *Physics,* Dr. E. F. Nichols, Nela Research Laboratories, Cleveland; *Chemistry,* Dr. W. F. Hillebrand, Bureau of Standards, Washington, D. C.; *Astronomy,* Professor John A. Miller, Swarthmore College; *Geology and Geography,* Dr. W. C. Mendenhall, U. S. Geological Survey; *Zoological Sciences,* Edward Linton, professor emeritus, Washington and Jefferson College; *Botanical Sciences,* Dr. George R. Lyman, dean of the College of Agriculture of the University of West Virginia; *Anthropology,* Dr. E. A. Hooton, Peabody Museum, Cambridge; *Psychology,* Dr. R. S. Woodworth, Columbia University; *Social and Economic Sciences,* President T. S. Baker, Carnegie Institute of Technology; *Historical and Philological Sciences,* Professor L. C. Karpinski, professor of mathematics at the University of Michigan; *Engineering,* Dr. A. E. Kennelly, Harvard University and the Massachusetts Institute of Technology; *Medical Sciences,* Professor William G. Macallum, the Johns Hopkins University; *Agriculture,* Professor L. R. Jones, University of Wisconsin; *Education,* Professor L. A. Pechstein, of the University of Cincinnati.

Officers of national scientific societies affiliated with the association and meeting at Cincinnati were elected as follows:

Mathematical Association of America—*President,* Professor H. L. Rietz, University of Iowa; *Vice-presidents,* Professor J. L. Coolidge, Harvard University, and Professor Dunham Jackson, University of Minnesota.

American Physical Society—Professor C. E. Mendenhall, University of Wisconsin, was reelected president.

The American Meteorological Society—*President,* Professor W. I. Wilham, Williams College; *Vice-president,* Dr. A. E. Douglass, University of Arizona; *Treasurer,* W. R. Gregg, U. S. Weather Bureau; *Secretary,* Professor Charles F. Brooks, Clark University.

The Metric Association—*President,* Dr. George F. Kunz, New York; *First Vice-president,* Professor Arthur E. Kennelly, Harvard University; *Second Vice-president,* Theodore H. Miller, Poughkeepsie, N. Y.; *Treasurer,* Frederick T. Roberts, New York; *Secretary,* Howard Richards, New York.

The American Society of Naturalists—*President,* Professor William H. Howell, The Johns Hopkins University; *Vice-president,* Professor Lester W. Sharp, Cornell University.

American Society of Zoologists—*President,* Professor Ross G. Harrison, Yale University; *Vice-president,* Professor Robert K. Nabours, Kansas State College.

American Association of Economic Entomologists—E. R. Sasscer, entomologist of the Federal Horticultural Board, was made chairman of the Section of Horticultural Inspectors, and *Third Vice-president* of the society, W. B. Wood, of Washington, D. C., was elected *Secretary* of the Section of Horticultural Inspection.

Botanical Society of America—*President,* Dr. William Crocker, Thompson Institute for Plant Research, Yonkers, N. Y.; *Vice-president,* Dr. A. F. Blakeslee, Station for Experimental Evolution of the Carnegie Institution.

Ecological Society of America—*President,* Professor E. N. Transeau, Ohio State University; *Vice-president,* W. C. Allen, University of Chicago; *Secretary-treasurer,* Professor A. O. Weese, James Milliken University. Barrington Moore, Brooklyn Botanical Society, was appointed *Editor* of *Ecology.*

SCIENTIFIC NOTES AND NEWS

DR. L. H. BAEKELAND has been elected president of the American Chemical Society.

DR. G. STANLEY HALL, ex-president of Clark University, was elected president of the American Psychological Association at the recent meeting at Madison, Wisconsin.

THE December meeting of the Chemical Society of Washington was devoted to analytical chemistry, in honor of the seventieth birthday of Dr. W. F. Hillebrand, chief chemist of the Bureau of Standards. Drs. E. T. Allen, H. S. Washington, C. E. Monroe,

F. W. Clarke and C. E. Waters addressed the meeting on various phases of their personal associations with Dr. Hillebrand. Dr. Hillebrand in responding to the greetings reviewed briefly some of his early personal experiences.

DR. JOHN G. FITZGERALD, professor of hygiene and preventive medicine and director of the Connaught Antitoxin Laboratories of the University of Toronto, has been elected to membership in the International Health Board of the Rockefeller Foundation.

DR. GIOACCHINO FAILLA, physicist at the Memorial Hospital, New York City, has received the degree of Doctor of Physical Science from the University of Paris for his studies of radium.

PROFESSOR A. FOWLER, professor of astrophysics, Imperial College of Science and Technology, and Mr. G. I. Taylor, fellow and lecturer in mathematics, Trinity College, Cambridge, have been appointed Yarrow research professors of the Royal Society, under the gift of £100,000 made by Sir Alfred Yarrow.

THE gold medal of the Royal Scottish Geographical Society has been awarded to Dr. Hugh Robert Mill, and the Livingstone gold medal to Dr. Marion I. Newbiggin, in recognition of their distinguished service in geographical research and exploration.

M. LE DUC DE BROGLIE, Dr. C. L. Guillaume and Professors Debye, Einstein, Groth and von Laue have been elected honorary members of the Royal Institution, London.

E. G. D. MURRAY, research bacteriologist to the Medical Research Council and formerly on the staff of the War Office Central Cerebro-spinal Fever Laboratory, has been elected to a fellowship at Christ's College, Cambridge.

PROFESSOR R. KRAUS, director of the Serum Institute at Sao Paulo, has resigned his appointment and returned to Vienna.

DR. JOSEPH T. SINGEWALD, JR., professor of economic geology at the Johns Hopkins University, and Mr. Lincoln Ellsworth, of New York, will sail for Peru in February to make a geologic cross-section of the Andes of Central Peru. The expedition will be known as the Ellsworth Expedition and the geologic materials collected will be worked up by the department of geology of the Johns Hopkins University.

DR. H. L. SHANTZ, physiologist in charge of the plant physiology and fermentation investigations of the U. S. Department of Agriculture, will sail from Marseilles on January 17 as a member of the Educational Commission to East Africa of the Phelps-Stokes Fund. The expedition plans to spend eight months in an investigation of the hygienic, economic and educational conditions of the country.

PROFESSOR A. L. KROEBÉR, head of the department of anthropology of the University of California, will leave in January for Mexico to lead an archeological expedition being sent out by the Mexican government.

DR. OLIVER C. FARRINGTON, curator of geology in the Field Museum of Chicago, returned this week to the United States from a seven months' exploring expedition into the interior of Brazil.

DR. M. P. RAVENEL, professor of preventive medicine and director of the public health laboratory at the University of Missouri, lectured before the Society of Sigma Xi at the University of Kansas on December 13, on the "Prolongation of Life." This lecturer initiated an annual exchange of lecturers between the Sigma Xi chapters at the two universities.

DR. MADISON BENTLEY, professor of psychology at the University of Illinois, will deliver the annual circuit lecture in February before the Chapters of Sigma Xi at the Universities of Missouri and Kansas.

AT a recent meeting of the Washington Chapter of the Society of Sigma Xi, ten-minute talks on "The most interesting thing I have seen the past summer" were made by various members, including L. O. Howard, on the Wellcome Medical Historical Museum in London; Paul Bartsch on under-water "movies" in the Bahamas; H. L. Shantz, on botanical excursions in Switzerland; E. E. Slosson (president of the local chapter), on electrification in Sweden; W. T. Lee, on the newly explored enormous caves in New Mexico; E. D. Ball, on petrified forests in the Bad Lands.

CONRAD N. LAUER delivered the fifth Cyrus Fogg Brackett Lecture at Princeton University on December 12. The subject of the lecture was "Engineering in American Industry." Mr. Lauer traced the great increase in production, product value and other data of American industry during the last hundred years.

PROFESSOR FRIEDRICH FULLEBORN, of the School of Tropical Medicine, Hamburg, Germany, delivered a lecture on "Filariasis" as one of the de Lamar lectures in hygiene, at the School of Hygiene and Public Health, Johns Hopkins University, on November 26.

THREE free public lectures on "Some chapters in the recent development of the theory of electrolytic dissociation" were given by Professor J. N. Brönsted, of the University of Copenhagen, at University College, London, on December 10, 12 and 14.

IN memory of Dr. William S. Halsted, surgeon-in-chief of the Johns Hopkins Hospital, the Johns Hopkins University and hospital held a public meeting

on December 16, at which addresses were made by Dr. Rudolph Matas, New Orleans; Dr. John M. T. Finney and Dr. William H. Welch, both of the Johns Hopkins University.

DR. SAM'L P. SADTLER, from 1874 to 1891 professor of organic and industrial chemistry at the University of Pennsylvania, has died at the age of seventy-six years.

DR. JAMES HARKNESS, Redpath professor of mathematics at McGill University and acting dean of the faculty of arts, died suddenly last week, at the age of fifty-nine years.

SIR FREDERICK TREVES, formerly Hunterian professor of anatomy and Wilson professor of pathology at the Royal College of Surgeons, died on December 7, aged seventy years.

JOHN EDWARD STEAD, F.R.S., a distinguished English metallurgist, died on October 31 at the age of seventy-two years.

THOMAS PRIDGIN TEALE, F.R.S., the eminent English surgeon and sanitarian, died on November 13, aged ninety-two years.

MAURICE LEBLANC, a leading French electrical engineer, died on October 27.

PROFESSOR DR. ED. VERSCHAFFELT, director of the Botanical Gardens, since the retirement of Hugo de Vries, and professor of plant physiology and pharmacognosy at the University of Amsterdam, died on June 26 in the fifty-fifth year of his age.

THE death is reported of Professor L. Milch, the distinguished petrographer of the University of Giessen.

DR. FUSAKICHI OMORI, professor of seismology at the University of Tokyo, president of the Imperial Earthquake Investigation Committee, died at Tokyo on November 8.

PROFESSOR C. C. O. R. TIGERSTEDT, professor of physiology in the University of Helsingfors, Finland, author of works on the physiology of the blood circulation, died on December 2, aged seventy years.

A MURAL tablet in memory of the late Professor James W. H. Trail, F.R.S., Regius professor of botany in the University of Aberdeen from 1877 until his death in 1919, has been placed in the classroom of the new department of botany, and was unveiled and presented to the university, on behalf of the subscribers, by Sir David Prain, on December 7. The tablet is mounted on a slab of slate. A portrait plaque in dull green bronze is surrounded by a wreath of oak leaves, acorns and galls. It is flanked by two Brazilian palms, and a decorative panel shows other natural objects representing the varied interests of Professor Trail. The tablet is the work of Miss Alice B. Woodward. The subscribers have also issued a memorial volume which, besides biographical and bibliographical matter, includes the "Flora of the City Parish of Aberdeen," a comparative and historical work of great detail which had occupied Professor Trail for many years, and had been completed shortly before his death.

As was announced last June, the friends, fellow workers, and pupils of the late Professor Augustus D. Waller, F.R.S., and Mrs. Waller, have resolved to establish a memorial in recognition of their lifelong devotion to physiological investigation. The memorial is to take the form of a fund, to be used for the encouragement of scientific research. The fund will be administered by the council of the London School of Medicine for Women, where Professor Waller was a lecturer in physiology, where Mrs. Waller was first a student, then demonstrator, and later a member of the council until her death, and where their daughter is lecturer in physics. Dr. Waller was lecturer in physiology at St. Mary's Hospital Medical School for nineteen years, and it has now been suggested that an additional memorial should be established in the form of a research room to be called the Waller Research Laboratory in connection with the physiological department.

Nature writes: "At the request of the local committee arranging the meeting of the British Association at Toronto next year, the Council of the association has changed the date of the meeting from September to August 6–13. The main party will leave England about July 25, and the excursion tour will be after the meeting instead of before it. The new arrangements will, we believe, be preferred to the old by most of the members who propose to attend the meeting, which is likely to be large and successful, as many members of the American Association also intend to take part in it. The British Association will meet in Southampton in 1925, and has received an invitation from the University and city of Oxford to meet there in 1926."

ANNOUNCEMENT is made by the Carnegie Institution of Washington that the Marine Biological Laboratory at Tortugas, Florida, will be open for use by a limited number of investigators in the summer season of 1924. It is expected that Mr. John W. Mills, engineer of the laboratory, will leave Key West with the *Anton Dohrn* for the initial trip to Tortugas about June 15. Further information concerning the proposed work may be obtained by addressing communications directly to the Carnegie Institution of Washington, Washington, D. C.

THE first building of the Army Medical School, located at the Walter Reed General Hospital, in Washington, is completed and is nearly ready for occupancy. The cost of the unit was $450,000. It contains laboratories for the various sections, operating rooms and a roentgen-ray unit. All typhoid vaccine for the army and U. S. Public Health Service will be made in one of the laboratories.

J. HARRISON BELKNAP, formerly assistant professor of electrical engineering at the Oregon State Agricultural College, has joined the control engineering division of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

UNIVERSITY AND EDUCATIONAL NOTES

AT the December meeting of the Rockefeller Foundation a total sum of $2,725,000 was appropriated in fulfillment of various pledges given previously by the foundation. In addition it was voted to continue certain fellowships in United States educational institutions. Of these appropriations, $1,000,000 will go to the medical school of the University of Chicago, $1,000,000 to the medical school of the University of Toronto, and $225,000 to the medical school of the University of Iowa. The remaining $500,000 is for the endowment of the medical school of the University of Alberta. The fellowships to be continued are in physics, chemistry, medicine and the biological sciences under the auspices of the National Research Council.

ST. STEPHEN'S COLLEGE, at Annandale on Hudson, N. Y., has received $125,000 from the estate of the late John R. Hegeman, of New York.

DR. JAMES ARTHUR HARRIS, of the Cold Spring Harbor Biological Laboratory, with which he has been associated since 1907, has been elected professor of botany and head of the department of botany of the University of Minnesota. He will take up his new work in September, 1924.

DR. JAMES H. MEANS, formerly assistant professor of medicine, has been appointed Jackson professor of clinical medicine, in the Harvard Medical School, to succeed Dr. David L. Edsall, the dean of the Medical School. Dr. Means is chief of the medical service at the Massachusetts General Hospital, Boston, in which capacity also he succeeds Dr. Edsall.

R. T. HASLAM has been promoted to a full professorship in the School of Chemical Engineering Practice, Massachusetts Institute of Technology.

PROFESSOR O. W. ALBERT, of Grinnell College, has been appointed head of the department of mathematics at the University of Redlands.

DISCUSSION AND CORRESPONDENCE

A SUGGESTION AS TO THE APPROXIMATE CHARACTER OF THE PRINCIPLE OF RELATIVITY

THE special principle of Relativity may be formulated partially somewhat as follows: In all systems moving with uniform velocity with respect to the fixed stars (called inertial systems by definition) the "laws of nature" take an especially simple form, and are the same for all the inertial systems.

Something equivalent to this seems to be an essential part of any rigorous formulation of the special principle. Now such a formulation demands an examination of what we mean by "laws of nature." Obviously we can not include among our laws of nature a statement that the stellar system has a certain apparent velocity, for this velocity is different for different inertial systems. We evidently mean that the laws of nature are the laws governing the happenings which take place solely in any one of the inertial systems, supposed isolated from the rest of the universe.

These considerations allow us incidentally to make an alternative formulation of the principle of relativity as follows: "It is actually impossible to detect uniform motion with respect to the fixed stars except by looking at them."

The necessity of supposing our inertial system isolated from the rest of the universe must arouse considerable misgiving, for it is not at all certain that it is physically possible to isolate a part of the universe from the rest. On the contrary, in such experiments as the gyroscopic compass and Foucault's pendulum, we have important evidence that happenings in our own system are essentially connected with all the rest of the universe, for the only significance which can be attached to an invariable direction, which these experiments show to exist, is a direction invariable with respect to the stellar universe. (Perhaps one reason that this connection is not more often prominent in our minds is that we are still very far indeed from being able to give that mechanistic account of the connection that our minds so insistently demand.) Admitting then the fact of such a connection, we find the ignoring of it by the principle of relativity logically difficult to justify. But we may physically justify the neglect of it if we can see any reason to expect that the effect of a translation may be very much smaller than that of a rotation. Such a difference is at once found in the enormous difference of actual velocities of translation and rotation when measured in cosmic units. In dealing with phenomena of connection with the entire universe, we naturally expect to employ coordinates relative to the entire universe. Now the earth in rotating about its axis runs through the entire possible range of co-

ordinates fixing its orientation in the universe in 24 hours, whereas in 24 hours its translational motion has changed its relative position in the universe by something of the order of 10^{-12}, taking the diameter of the stellar universe as 300,000 light years.

It appears very natural therefore to expect that any translational effects are so small compared with any rotational effects that they are far beyond the reach of present observation, but in principle we recognize that such effects may well exist, and therefore the special principle of relativity may very probably be only a close approximation.

P. W. BRIDGMAN
THE JEFFERSON PHYSICAL LABORATORY,
HARVARD UNIVERSITY, CAMBRIDGE, MASS.

CONCERNING EXCEPTIONAL HAILSTONES

THE note in a recent number of this Journal (58: 443, 30 Nov. 1923) describing peculiar hail observed by Professor Bevan recalls that I made very similar observations some years ago during a hailstorm on the coast of California at Carmel. The conditions permitted a fairly close study of the structure of the hailstones which fell, and I was able to make a number of sketches showing their form, size and structure. An account of my observations was published in the transactions of the Royal Society of Canada, Vol. X., Series III, pages 47–50, 1916.

It seems probable that the meteorological conditions along the Pacific coast are not infrequently such as to produce the particular kind of hail described by Professor Bevan and by myself.

FRANCIS E. LLOYD
McGILL UNIVERSITY

SCIENTIFIC BOOKS

DEAN'S BIBLIOGRAPHY OF FISHES[1]

THE monumental "Bibliography of Fishes," begun by Professor Bashford Dean in 1890, and continued with help of Charles R. Eastman, Eugene W. Gudger, Arthur W. Henn and many others, has been brought to completion by the issue of the third volume. To call this work monumental is only the beginning of defining adjectives. It is majestic, commanding, and, above all, insistently useful. No one in the future can attempt research in ichthyology without having these volumes at his elbow. The sciences which rest on observation, the study of structure, habits, distribution, classification and evolution of living organisms, have gone so far and through so many hands that they are likely to be swamped in the thickets by themselves created. A system of clearing-house is vitally necessary. This is true in every field of natural history, not least in the fishes, the monstrous, ancient and varied group from which all the higher classes of vertebrates are offshoots.

In brief, Dean and his associates have tried to furnish a clue to everything of any permanence which has been written about fishes. They have listed every book or paper which has added to knowledge, and some which unwittingly have turned science backward. In the first two volumes the authors catalogue, with occasional comments, about 35,000 titles of books and memoirs since 1758, the date of the tenth volume of Linnæus's "Systema Naturae," with which scientific classification of animals began. The third volume, now before us, contains everything that the worker could desire which the other volumes omit. The title page asserts that it includes "indices, general bibliographies, periodicals relating to fishes, early works, voyages and expeditions, addenda and errata of Vol. I and II."

This modest enumeration will bear analysis. We find first a list of anonymous papers of varying importance, but worthy of record. These relate largely to fishing interests. Next comes, as "Addenda," papers overlooked in the first and second volumes. For never yet was a voluminous record absolutely complete. This fact was noted by Aristotle, who is quoted as saying (in substance): "It is pedantry to expect a degree of accuracy which the subject does not permit." Next follow titles of publications before Linnæus, though these are not considered in modern taxonomy, for a system of naming must have its beginning somewhere, yet knowledge owes much to some of these early authors. Clear minds and keen eyes came into civilization long before the printing press or the steam engine made diffusion of opinion easy. Among these ancient worthies we may name Aristotle, of course; Ælian, inventor of fly-fishing; Aldrovandi; Ausonius, who sang the trout and grayling of the Moselle; Artedi, who taught Linnæus most that he knew of fishes; Gesner; Gronovius; Ray, Rondelet and Willughby. Among these stands Izaak Walton, in a class by himself. Next follows a long list of early anonymous writers, and a record of bibliographies, large or small, the work of preceding compilers. The fifth chapter records voyages and expeditions in which fishes and fish information have been secured. Among these, our own "Albatross" holds an honorable place. Next comes the long list of periodicals devoted to fish culture. Then follow the errata and corrigenda of the first two volumes, these largely relating to initials of foreign writers and to duplications in reprints.

[1] "A Bibliography of Fishes." By Bashford Dean. Enlarged and edited by Charles R. Eastman. Vol. I (A. to K.); Vol II (L. to Z.).

"A Bibliography of Fishes." By Bashford Dean. Extended and Edited by Eugene Willis Gudger, with the cooperation of Arthur Wilbur Henn. Vol. III (Indices, etc.). American Museum of Natural History, New York.

Of most importance to workers in ichthyology, and involving a prodigious amount of reading and research, is Part VIII, termed the "Subject index." Here every feature of fish structure and fish life has its special bibliography. In each case the student is assisted by an analysis and history of the problems concerned, and the most important papers, Bædeker-fashion, are indicated by a star (*). For example, the first topic, "Abdominal pores of fishes," is given a page and a half of elucidation. "General morphology" receives three and a half pages, "Angling" two pages, and "The evolution of fishes" four pages. The unsolved problem of the origin of the pectoral limb is intelligibly presented, and the three or more conflicting theories are made clear.

The subject of geographical distribution, vital to any serious grasp of the facts of evolution, receives six pages, devoted to results of faunal studies all over the globe. Paleontology, equally important, as an index of results of evolution of fishes throughout the ages, has thirteen more.

The last section (VIII) consists of a systematic subject index covering all the papers which treat somewhat fully of the taxonomy and presumable evolution of the different families and higher groups. Individual genera are sometimes mentioned, but a complete analysis of the 8,000 genera, real or nominal, would demand another large volume. It is the less needed, because the *Zoological Record* of London attempts each year to do this work, a matter of the greatest importance to every systematic worker in any field. The rumored danger that the *Zoological Record* might suspend publication for want of support has given a shock to every worker on the details of classification, for without it taxonomists would sail an uncharted sea. This would be far more precarious now than in the years between 1845 to 1864 (Agassiz to Günther), when no continuous records of genera or species were kept anywhere. The number of workers and of centers of publication have enormously increased in these sixty years, and to abandon the regular annual record of discoveries would be one of the most disastrous of the many damages inflicted on science by war.

Finally, a finding index refers to all important topics, not persons, mentioned throughout the book.

In conclusion, the reviewer may again voice the profound indebtedness of every student of fishes in whatever field, an indebtedness which will endure so long as investigators busy themselves with knowledge of fishes. It is indeed, as Izaak Walton once pertinently observed, "good luck to any man to be on the good side of the man that knows fish."

DAVID STARR JORDAN

STANFORD UNIVERSITY

PROGRESS IN THE CERTIFICATION OF BIOLOGICAL STAINS

IN a recent article[1] in this journal announcement was made of the certification of methylen blue that had been undertaken by the Commission on Standardization of Biological Stains. This present notice is published to call attention to the fact that haematoxylin has now been put upon this same basis, and that samples of three other stains, namely, basic fuchsin, safranin and eosin, are now in the hands of the commission for the testing preliminary to such certification. Samples of these stains prepared from batches that have been found satisfactory by members of the commission will soon be available.

In the article just mentioned reference was made to cuts representing the labels to be used on these certified stains. No cuts accompanied the article, however, because it was found that they were not suitable to reproduction on the paper used in this journal. The inability to use these cuts was discovered too late to make the necessary correction in the proof. There are two of these labels issued by the commission. One of them is intended for use by those companies who want to employ it in addition to their regular label, the other is to be used by the companies who want to have the commission label the main label on the bottle bearing the name of the stain. The statement on the first of these labels is as follows:

Found satisfactory by Commission on Standardization of Biological Stains for purposes mentioned on main label. Use for other purposes not contra-indicated unless specifically so stated on said label.

Will users please report unsatisfactory results to the chairman, H. J. Conn, Geneva, N. Y.

The statement on the second label is the same except for minor verbal differences to indicate the fact that it is itself the main label on the bottle.

In the article above mentioned on "Certified Methylen Blue," the names of six concerns were given whose products have been certified. It was not mentioned at this time that such products could be obtained from regular dealers handling laboratory supplies. Attention is called to the fact, now, however. There is no need of ordering these stains directly from the companies mentioned. Any one desiring them can obtain them from his regular dealer by specifying one of the companies listed or by merely indicating that the stain bearing the certification of this commission is desired.

COMMISSION ON STANDARDIZATION OF STAINS

H. J. CONN, *Chairman*

GENEVA, N. Y.,

DECEMBER 1, 1923

[1] SCIENCE, 58, p. 41. July 20, 1923.

THE AMERICAN CHEMICAL SOCIETY

DIVISION OF BIOLOGICAL CHEMISTRY

J. S. Hughes, *chairman*

W. T. Bovie, *secretary*

AT the sixty-sixth meeting of the American Chemical Society held in Milwaukee, Wisconsin, September 10 to September 14, 1923, the Division of Biological Chemistry held a symposium on Biophysical Chemistry. The symposium was followed by the regular scientific program of the division.

There were six papers on the symposium program, the first three of which dealt with the use of physical-chemical methods in biological investigations:

C. H. Bailey, of the University of Minnesota, discussed the use of electrolytic conductivity measurements, hydrogen-ion concentration measurements, viscosity measurements, and the determination of colloidal properties in the study of cereals.

J. Arthur Harris, of the Carnegie Institution of Washington, Station for Experimental Evolution, discussed the use of osmotic concentration measurements, specific electrical conductivity measurements, hydrogen-ion concentration measurements, etc., in investigations on the geographic distribution of plants.

C. L. A. Schmidt, University of California, Berkeley, California, described a method for the separation of the hexone bases from certain protein hydrolysates by electrolysis.

The other three papers on the symposium program dealt with the physical chemistry of the structure of protoplasm:

W. T. Bovie, of Harvard University, discussed the molecular organization of protoplasm and pointed out the importance of the colloid interfaces in determining this organization. He pointed out that protoplasm has a molecular organization in the three dimensions of space, and since it is the seat of a series of regulated and coordinated chemical events it has a dynamic organization in the dimension of time. It is necessary to consider these four dimensions in explaining the activity of living things.

W. D. Harkins, of the University of Chicago, presented a theory of emulsions and their inversion, according to which the stability of emulsions of the type produced by soap, is dependent upon the existence around the droplets of a film of molecules with the polar ends oriented toward the water and the non-polar ends toward the oil. A second and independent part of the theory considered the molecules as capable of representation by the frustra of cones (or in a plane, by wedges). The water or the oil will be the continuous phase of the emulsion according as the polar or the non-polar ends of the molecules form the bases of the frustra.

H. H. King and J. S. Hughes discussed the part played by surface tension in the organization of living matter and presented a theory of emulsions similar to that of Harkins. They invoked von Baeyer's theory of tension to account for the shape of the molecule forming the emulsion interfaces and thus determining which phase of the emulsion is continuous.

There were thirty-two papers on the general program, one third of which were concerned with vitamines. Many of them elicited lively discussion.

The following officers were elected: *Chairman,* W. T. Bovie; *secretary,* R. Adams Dutcher; *executive committee,* W. T. Bovie, J. S. Hughes, R. Adams Dutcher, Carl L. A. Schmidt, L. S. Palmer, G. E. Holm.

SYMPOSIUM PROGRAM

Physical chemistry in the cereal industries: C. H. BAILEY.

Physico-chemical properties of the tissue fluids of agricultural plants: J. ARTHUR HARRIS.

The application of certain physical-chemical principles to the separation of the hexone group of amino acids: C. L. A. SCHMIDT.

On the nature and structure of protoplasm: W. T. BOVIE.

A theory of emulsions and the inversion of emulsions: WILLIAM D. HARKINS.

The part played by surface tension in the organization of living matter: H. H. KING and J. S. HUGHES.

The nutritive value of the proteins of milk from the standpoint of reproduction: BARNETT SURE. On rations containing 12 to 20 per cent. milk proteins, and in the presence of a liberal supply of the fat-soluble and the water-soluble vitamines, and dextrin; and an adequate salt mixture, no successful reproduction was secured. All rations contained 0.4 per cent. cystine, and during the breeding and lactation periods certain rations were fortified with lysine and proline. Still all the females remained sterile. That another as yet unidentified dietary syndrome might play a prominent part in reproduction is suggested from the following paper.

Suggestive evidence for the existence of a specific vitamin for reproduction: BARNETT SURE. In connection with studies on the rôle of cystine in reproduction it has been observed that on a 40 per cent. velvet bean pod meal ration, containing a liberal supply of dextrin, 9 per cent. casein, 2 per cent. cod liver oil, an adequate salt mixture, and dextrin carrying alcoholic extracts of 10 grams of ether-extracted wheat embryo in 100 grams of ration, fertility and a certain degree of success in reproduction is always obtained, the degree of success of reproduction increasing with the concentration of the water-soluble B vitamin. The experimental evidence suggests that the fertility and partial success of reproduction is to be ascribed to a specific vitamin that controls reproduction other than water-soluble B vitamin.

The relative vitamin and mineral values of cow pea, soy bean, alfalfa, lespedeza and prairie hays as ordinarily cured: J. W. READ. The rat seems to utilize satisfactorily as high as 40 per cent. of these hays. Cow pea, alfalfa and prairie hays were good sources of vitamin A at a 20 per cent. level. Soy bean and lespedeza were almost as good at 10. Regarding vitamin B, prairie hay was poor at 40, cow pea and soy bean were good at 20, but alfalfa and lespedeza were fairly good only at 20. As a source of minerals, when fed at a 10 per cent. level prairie and cow pea hays were poor, lespedeza fair, while soy bean and alfalfa were good.

Studies of the vitamin potency of cod liver oil. VI. The effect of storage of livers on the vitamin A potency of cod liver oil: ARTHUR D. HOLMES. Cod liver oils were extracted from fresh cod livers; from livers that had been stored six months; and from livers stored one year. The results of three series of comparable tests in which albino rats suffering from vitamin A starvation were fed graduated amounts of the three oils noted above, showed that livers which had been stored at a low temperature out of contact with air had as high a vitamin potency as oil rendered from fresh livers. One milligram per day of each of the oils contained sufficient vitamin A to insure good growth in albino rats.

On the cystine deficiency and the vitamin content of the lentil, Lens esculenta Moensch: D. BREESE JONES and JOSEPH C. MURPHY. Feeding experiments with albino rats showed that the proteins of the lentil are deficient in cystine. Young animals fed a diet, the sole source of protein of which came from the lentil, rapidly declined in weight and died in 17 to 49 days. On the same diet, after addition of 0.36 per cent. of cystine, the animals grew at an average rate not far from normal. Slightly better results were obtained when the lentil had been cooked than when raw. Two grams daily of raw lentil furnished about the minimum quantity of vitamin-B required by the albino rat for growth at the normal rate. The lentil also contains appreciable quantities of vitamin-A.

Dried yeast as a supplement to a good poultry laying ration as a means of increasing egg production: A. J. SOUBA, H. C. KNANDEL and R. ADAMS DUTCHER. Ten pens (45 birds per pen) of white leghorn pullets and hens were fed for ten months on wet and dry mash rations, with and without yeast and with and without artificial lights. Biometrical methods were used in interpreting the data with regard to body weight, egg production, size and weight of eggs and food intake. Practically all groups, receiving yeast, showed a response, although in some cases the differences were not significant. When pullets were subjected to longer feeding periods by use of electric lights, significant differences were obtained in favor of the yeast-fed pens.

The influence of heat on certain physical and chemical properties of cow's milk: J. ROY HAAG, STANLEY R. SHIMER and R. ADAMS DUTCHER. It was impossible to demonstrate a calcium deficiency in pasteurized milk by the use of feeding methods. Raw and heated milks were passed through an ultra filtration apparatus under a pressure of 200–250 pounds, using nitrogen gas. No significant differences could be noted between the sera of raw and heated milks with regard to freezing point depression, hydrogen ion concentration, and the amounts of calcium and phosphorus present. When raw and heated milks were centrifuged at high speed and the intermediate layer of skim milk analyzed for calcium and phosphorus no significant differences could be noted.

The storage of vitamin B in the albino rat: EMMA FRANCIS and R. ADAMS DUTCHER. A general description of the technique adopted at the Pennsylvania State College. It was pointed out that some animals eat very large proportions of their fecal matter. Such animals may grow normally for months on a diet deficient in vitamin B, due to the fact that the vitamin is apparently utilized again and again. When screens were introduced this trouble was eliminated. Rats can not store large quantities of this vitamin for long periods. The importance of accurate food intake records was emphasized.

The application of the Benedict-Osterberg method to the quantitative estimation of carbohydrates in plant tissues: WALTER THOMAS and R. ADAMS DUTCHER. The colorimetric method of Benedict and Osterberg (slightly modified) was far superior to the usual copper reduction methods. Glucose, fructose, l-arabinose, l-xylose, maltose, sucrose and starch can be satisfactorily determined by this method. It was possible to obtain practically theoretical recovery of these carbohydrates when they were added, in quantities approximating 5 to 10 milligrams, to plant extracts.

Experiments on the isolation of the antineuritic vitamin by picric acid precipitation: ATHERTON SEIDELL. Addition of picric acid to a concentrated vitamin extract, prepared from brewer's yeast by the fuller's earth method, yields a highly active precipitate which appears to contain at least two picrates. By solubility differences in 95 per cent. acetone, there can be separated a well crystalline picrate melting at about 200°, but showing very little activity, and a less well crystalline product, which has been found to be active in doses of one milligram per day, when given to pigeons fed only on polished rice.

Studies in the genus Mentha. 8. The oil of Mentha piperita L., 1922: ROLAND E. KREMERS. The oil of peppermint produced by the Wisconsin Pharmaceutical Experiment Station in 1922 was examined for its constituents. Phellandrene was present in traces only, if at all. The presence of pinene and limonene was not conclusively proved. Cineol (cineolic acid m.p. 206°), l-menthol (m.p. 42°), and l-menthone (semicarbazone m.p. 184°) were found as expected. Two menthenones, d-piperitone (semicarbazone m.p. 215°) and d-pulegone semicarbazone m.p. 171°) were isolated. The cause for the difficulty experienced in crystallizing l-menthol from American peppermint oils was studied and is thought to be due to another alcohol occurring in the menthol fractions.

Studies in the genus Mentha. 10. A preliminary study of the reduction of d-pulegone by palladium and hydrogen: ROLAND E. KREMERS. d-Pulegone from M. arvensis was reduced by Pd-H until action had practically ceased.

The oil rectified by steam had $[\alpha]_0 + 21.19°$ and no longer reacted with neutral sulfite. It distilled largely between 205 and 210° C.; b.p. menthone is 207–8° C. The semi-carbazone consisted largely of a fraction m.p. 183–4°. The regenerated ketone had $[\alpha]_0 - 7.4°$; semi-carbazone from regenerated oil melted at 184°. A lower fraction of semi-carbazone regenerated an oil, $[\alpha]_0 + 25.7°$. Semi-carbazone from this oil melted at 175–6°C. A mixture of menthones had accordingly resulted.

Studies in the genus Mentha. 11. The occurrence and significance of menthenones in mentha oils: ROLAND E. KREMERS. A menthenone-3 is known to occur in all investigated Mentha oils except M. spicata L. and M. citrata Ehrh. Since d-menthone-4 (8) one-3, (pulegone) and 1-menthanol-3 (menthol) are the only two compounds which become preponderant constituents in mentha oils, a genetic relationship is suggested. It is conceivable that menthone and menthol are formed by successive reductions. Charabot found that oil production is associated with chlorophyll, *i.e.*, reducing, functions. Brooks could not oxidize menthol with peppermint oxidase. Since piperitone reduced by Pd-H gives an isomenthone and pulegone a menthone, it may be possible to follow the plant syntheses.

Biochemistry of plant diseases VI. Physical and chemical basis of resistance to brown rot in plums: J. J. WILLAMAN and N. C. PERVIER. Mechanical tests have been devised for measuring toughness of skin and firmness of flesh of plums. It has been found that those varieties of plums which are resistant to brown rot have firmer flesh, tougher skin, and higher content of fiber and pentosans than the susceptible varieties. The crude fiber relation is so sharp that any variety having 6 per cent. or more of crude fiber on the dry basis can be classed as resistant. As ripening progresses, the texture of the resistant varieties remains firm, while that of the susceptible becomes softer. The crude fiber content also is less in ripe plums and at this stage they are the most susceptible to the rot.

The multiple nature of bios: E. I. FULMER, W. W. DUECKER and V. E. NELSON. Alfalfa extract was fractionated into four fractions with ethyl alcohol. No. 1 insoluble in 40 per cent.; No. 2 insoluble in 70 per cent.; No. 3 insoluble in 95 per cent.; No. 4 soluble in 95 per cent. Each precipitate was analyzed for nitrogen and protein and the optimum concentration for yeast growth determined. The basal medium had the following composition; Ammonium chloride, 0.236 gms; di-potassium phosphate, 0.1 gm; calcium chloride, 0.1 gm; calcium carbonate, 0.04 gms; cane sugar, 10 gms, per hundred cc. Combination of the optimum concentrations of 1 and 3 produced greater stimulation of yeast growth of either alone. Fractions 1 and 4 are different and Bios is not a single substance.

Determination of iodin in natural waters: J. F. MCCLENDON. The method of reduction of iodate to iodide and the oxidation of iodide to iodin, shaking this out with carbon-tetrachloride and determining colorimetrically is adapted to quantities of .001 milligrams or greater by the use of a Bausch and Lomb colorimeter, cups holding 1 cc at 2 cm depth. Water residue is first ignited in pure oxygen in a silica combustion tube with the end bent down into KOH solution.

Determination of iodin in large quantities of foodstuffs: J. F. MCCLENDON. The method is similar to the method for water except that the sample is burned in two stages. The first stage in an apparatus similar to the silica tube described before but large enough to burn several kilograms. KOH solution is evaporated down and together with the ash is reburned in the smaller tube and analyzed as in the preceding.

Relation of distribution of iodin to simple goitre: J. F. MCCLENDON. There are two endemic centers for goitre in the United States. One centers in Michigan and the other in northern Idaho. The goitrous regions decrease in severity from these centers, the goitre-free region being the broadest in the Gulf States with only a narrow strip on the Atlantic coast and a still narrower strip on the Pacific coast. Analysis of iodin in drinking water from about one hundred localities shows an inverse ratio between the iodin and goitre prevalence. It would take one thousand years for a person to drink enough of Lake Superior to obtain the iodin which is in his thyroid gland.

The effect of vitamin-carrying additions to the diet of baby chicks: ALVIN R. LAMB and CHARLES W. KNOX. Chicks were fed immediately after hatching in small outdoor lots with no vegetation under the care of hens, which were fed separately. A basal ration of cereal grains and by-products, some meat scrap, and 5 per cent. of alfalfa meal, comparable to practical chick rations, was used. Cod liver oil, butter-fat, yeast, tomato juice and buttermilk were fed as vitamin carriers. The yeast and buttermilk lots grew more rapidly and economically, and the lots receiving the fats were not so good as the control lots.

Further chemical studies on the placental hormone: PAUL M. GIESY. A method has been developed for preparing a concentrated material containing the hormone; yield, 0.02 per cent. This concentrate contains cholesterol and other lipoidal impurities, but contains no nitrogen, sulfur or halogens. The hormone is lipoidal in solubility. It diffuses through rubber in acetone, benzene, ether and chloroform solution, and through collodion in 75 per cent. and 62½ per cent. alcohol solution. From the effect of various reagents on its activity, it appears to be an unsaturated compound of ester-like nature, containing neither the carbonyl, amino, imino, nor hydroxyl grouping.

The importance of iron in reproduction: J. S. HUGHES. White rats reared from weaning time to maturity on a diet of cows' milk failed to produce any young. The addition of vitamins had no beneficial results. The addition of iron in the form of iron citrate, however, brought about normal reproduction.

The relation of sunlight to rickets (weak legs) in chickens: J. S. HUGHES. Chickens receiving a standard scratch feed and mash, supplemented with sprouted oats and buttermilk, developed rickets (weak legs) when deprived of direct sunlight. Chickens receiving same feed but given sun bath developed normally, although they were confined in very small pen, with little opportunity